

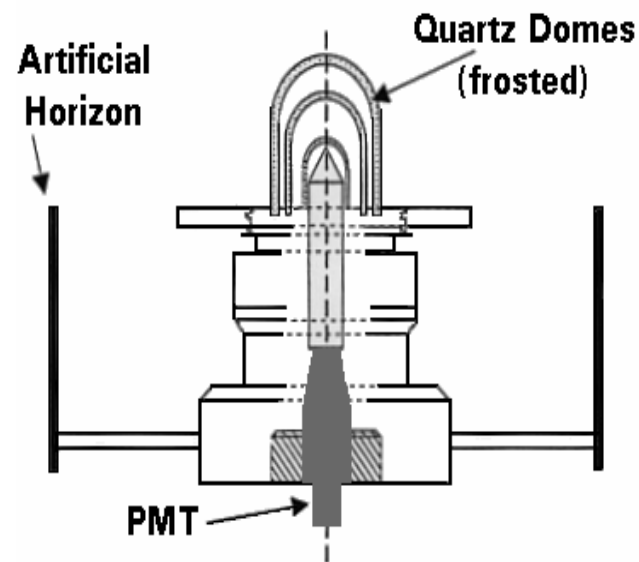
Cryogenic Hygrometer and Filter Radiometers

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Filter Radiometer - Photolysis Rate of NO₂

***J*(NO₂) - FILTER RADIOMETER**
Commercially Available - METCON

TECHNIQUE	Solar radiative flux measured with photodiode tube via frosted quartz hemispherical dome and rod for a light guide and optimum glass filters.
BAND-PASS FILTERS	310 → 420 nm (2*UG3 + 1*UG5) Restricts output signal to broadband integrated actinic flux - proportional to photolysis rate of NO ₂ .
CALIBRATION	Calibrated with reference <i>j</i> (NO ₂) radiometer traceable to a chemical actinometer.
UNCERTAINTY	10 %
UNITS	<i>J</i> (NO ₂)- sec ⁻¹



J(NO₂) Filter Radiometer Calibration

NCAR Marshall Field Site

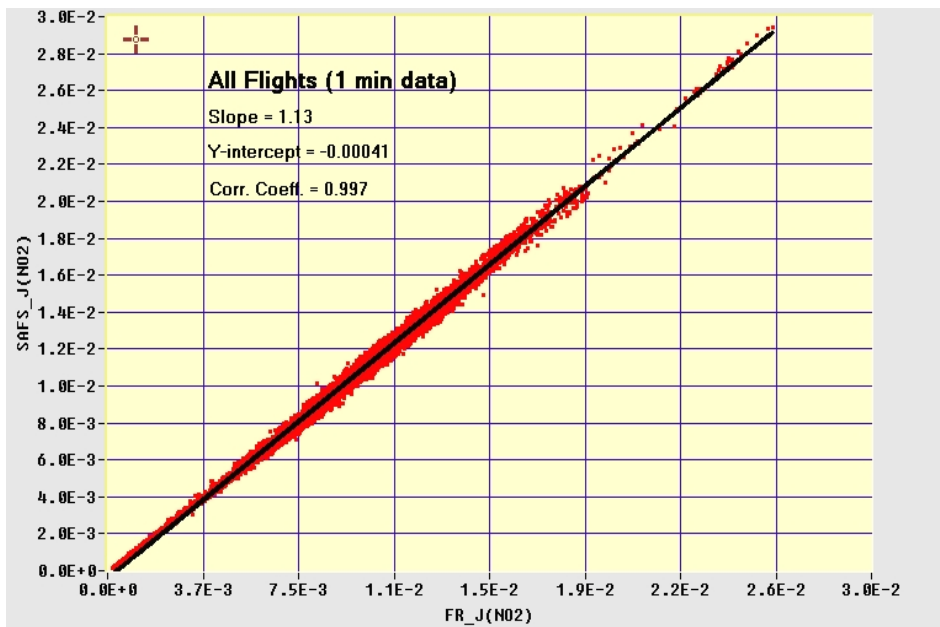
Rick Shetter
Barry Leffer
Sam Hall

There are several factors that influence the FR performance:

- Mounting and the use of shadow rings to minimize platform (DC-8) reflections and providing a true hemispherical FOV for each zenith and nadir-viewing radiometer.
- Optics and light guide to provide a good angular response
- Cal factor that accurately translates broadband integrated actinic flux between 310 and 420 nm to J(NO₂).

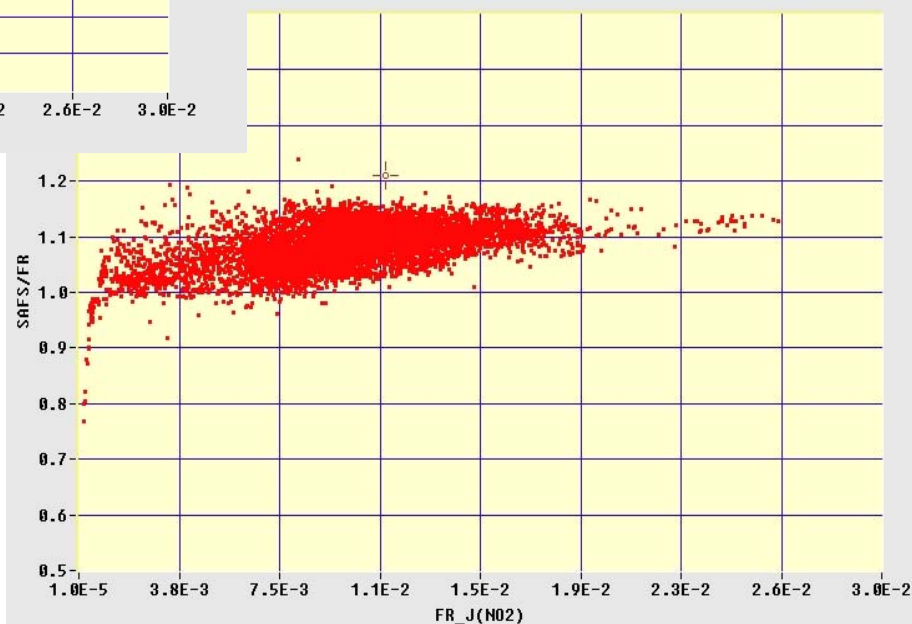
(Calibration and intercomparison instrumentation available at the Marshall Field Site include traceable actinometer calibrated master FR's and NCAR actinometer/spectroradiometer systems.)

DC-8 Filter Radiometer/SAFS Correlation



Correlation Plot

Ratio of Total J(NO2),
SAFS
FR



IN SITU H₂O VAPOR MEASUREMENTS

Cryo Hygrometer

Principal H₂O Vapor Measurement Technique - Chilled Mirror Hygrometry

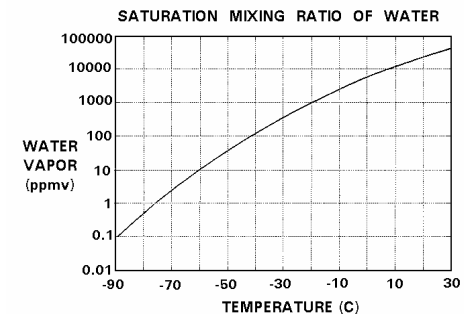
Chilled mirror technique is capable of fundamental accuracy – measures a primary humidity parameter.

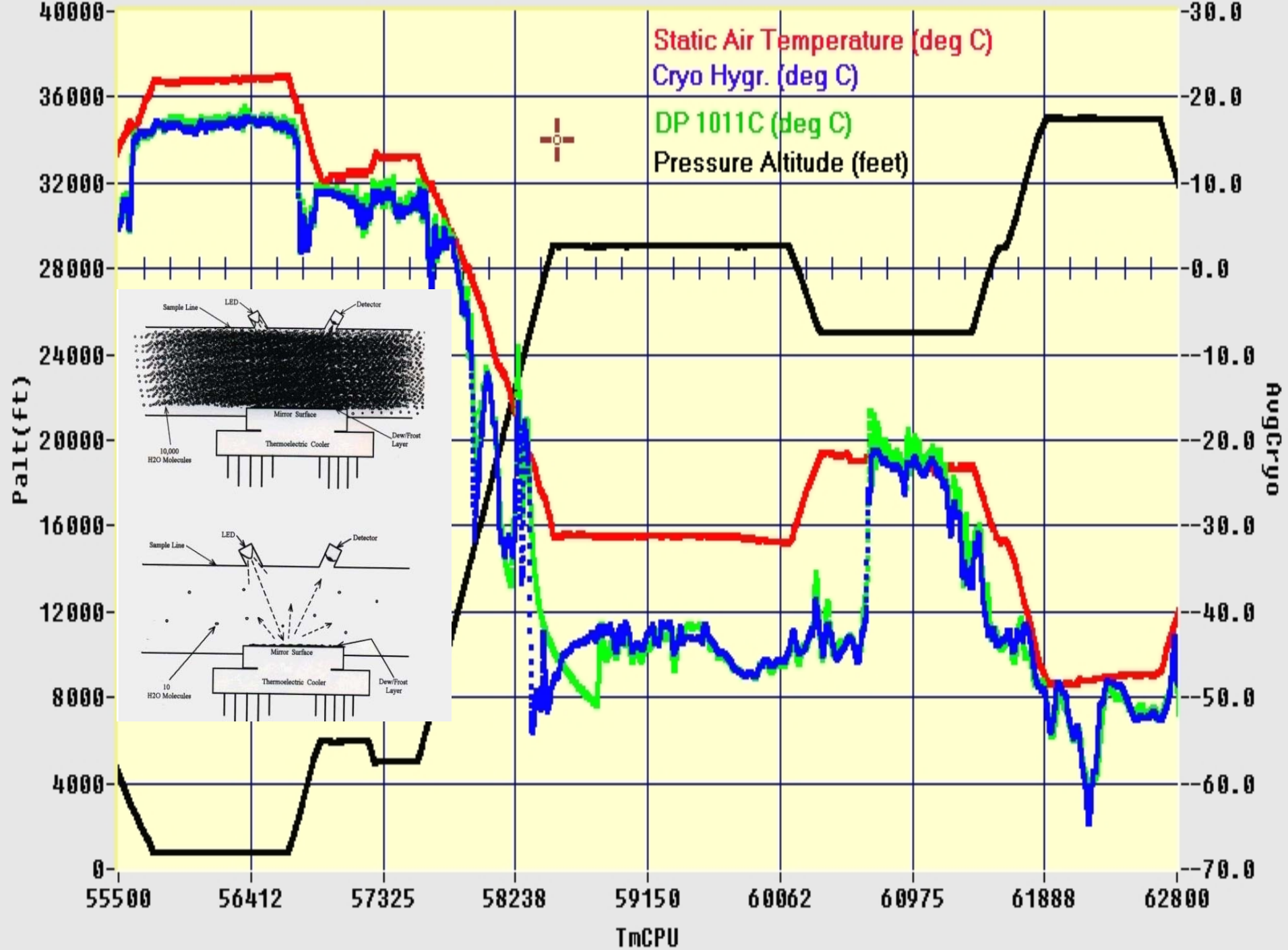
Tropospheric H₂O vapor concentrations vary dynamically over 5-6 orders of magnitude.

Enhance application of H₂O vapor data sets via an understanding of the measurement technique.

“...theoretical calculations and published specs are limited in their descriptions of complex measurement conditions.... no one can anticipate all uses or combinations of environmental conditions to which an instrument will be subjected. It is important for the user to be aware of the sensors’ limitations.”

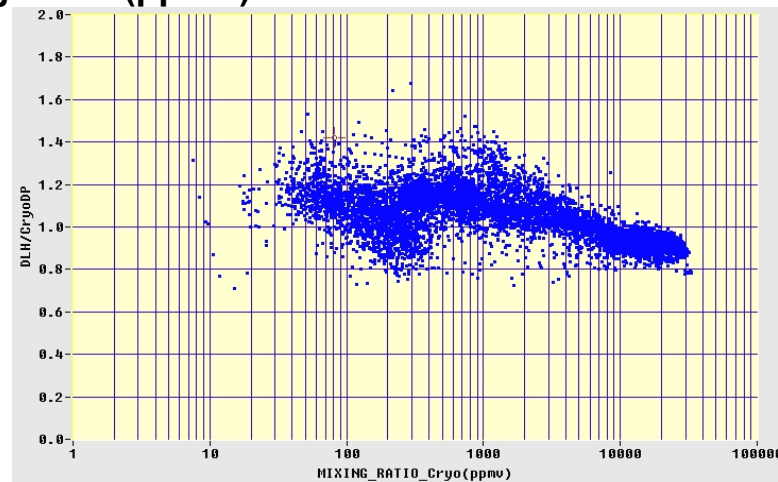
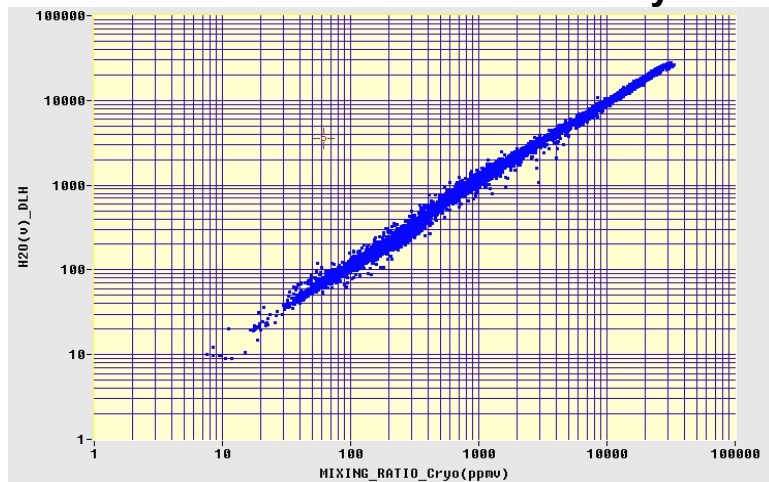
Sensors, Oct, 1991



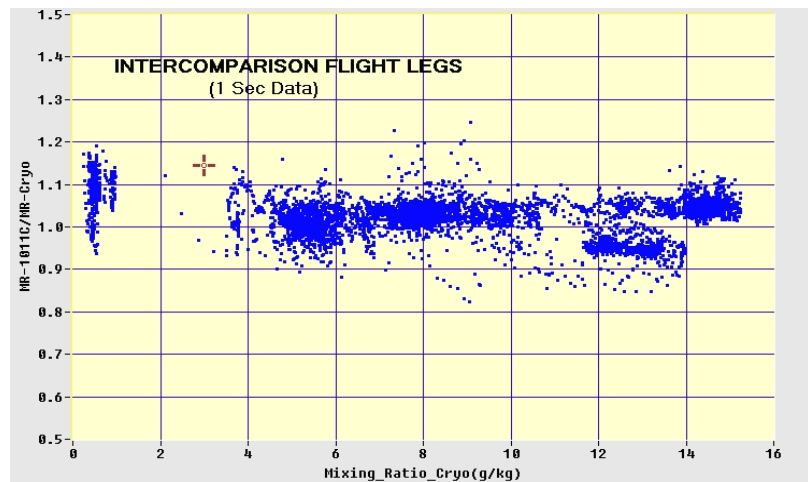
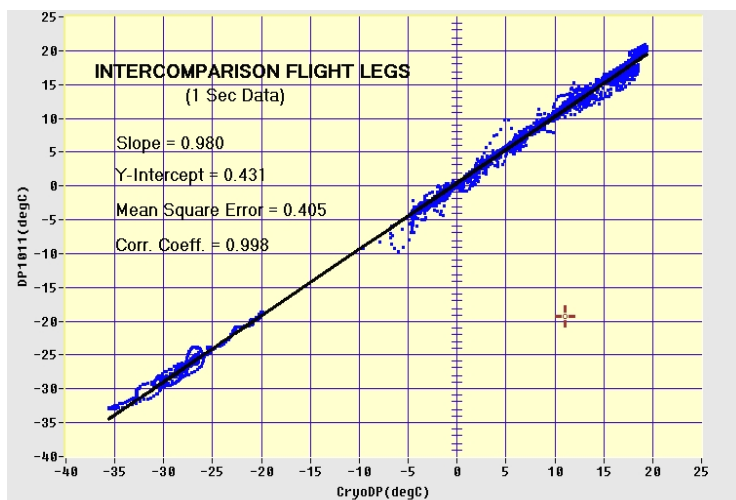


DC-8 Water Vapor Measurement Comparisons

All DC-8 Flights (1 min data)
DLH vs. Cryo Mixing Ratio (ppmV)



Intercomparison Flight Legs Chilled Mirror Hygrometers
(Cryo vs. 1011C)



Archived Data

File Name:

cryo_dc8_2004mmdd_ra.ict → nav_dc8_2004mmdd_r0.ict

- INSTRUMENT_INFO: Merged data set compiled by combining ICATS Navigation Data + Cryogenic Hygrometer + J(NO₂) Filter Radiometer (Zenith and Nadir Viewing)
- R0: J(NO₂) corrected for altitude, temperature, and SZA
- R0: Parameters Associated With Water Vapor Are Calculated Using DP_Proj (deg C)
- Source of Proj_DP identified by value identified as FLAG_DP_PROJ (0 - Null Data; 1 - Cryo; 2 - 1011C)

Parameters (**Measured & Calculated**):

- **DP_PROJ (degC)**
- FLAG_DP_PROJ
- *REL_HUMIDITY_ICE (%)*
- *REL_HUMIDITY_H2O (%)*
- *SAT_VAPOR_PRESSURE_H2O (mb)*
- *SAT_VAPOR_PRESSURE_ICE (mb)*
- *VAPOR_PRESSURE_H2O (mb)*
- *VAPOR_PRESSURE_ICE (mb)*
- *MIXING_RATIO (g/kg)*

- *j(NO₂)Nadir (1/s)*
- *j(NO₂)Zenith (1/s)*

Applied Dew/Frost Point - 101

Measured Primary Humidity Parameter = Dew/Frost Point (Deg C)

Calculated Parameters:

$$\text{VAPOR_PRESSURE_H2O (mb)} = 6.1121 \text{ EXP}[17.502 \times T / (240.97 + T)]$$

$$\text{VAPOR_PRESSURE_ICE (mb)} = 6.1115 \text{ EXP}[22.452 \times T / (272.55 + T)]$$

$$\text{SAT_VAPOR_PRESSURE_H2O (mb)} = 6.1121 \text{ EXP}[17.502 \times T / (240.97 + T)]$$

$$\text{SAT_VAPOR_PRESSURE_ICE (mb)} = 6.1115 \text{ EXP}[22.452 \times T / (272.55 + T)]$$

Where,

T = Dew/frost point for VAPOR_ PRESSURE calculations and Static Air Temp. for SAT_ VAPOR_ PRESSURE

$$\text{REL_HUMIDITY_H2O (\%)} = \frac{\text{VAPOR_PRESSURE_H2O (mb)}}{\text{SAT_VAPOR_PRESSURE_H2O (mb)}} \times 100$$

$$\text{REL_HUMIDITY_ICE (\%)} = \frac{\text{VAPOR_PRESSURE_ICE (mb)}}{\text{SAT_VAPOR_PRESSURE_ICE (mb)}} \times 100$$

$$\text{MIXING_RATIO (g/kg)} = \frac{0.622 \times 10^3 (\text{VAPOR_PRESSURE})}{(\text{STATIC PRESSURE}) - (\text{VAPOR_PRESSURE})}$$

Where,

VAPOR_ PRESSURE_ H2O is used for Dew/Frost Points equal or greater than 0 degC and

VAPOR_ PRESSURE_ ICE for Dew/Frost Points less than 0 degC.

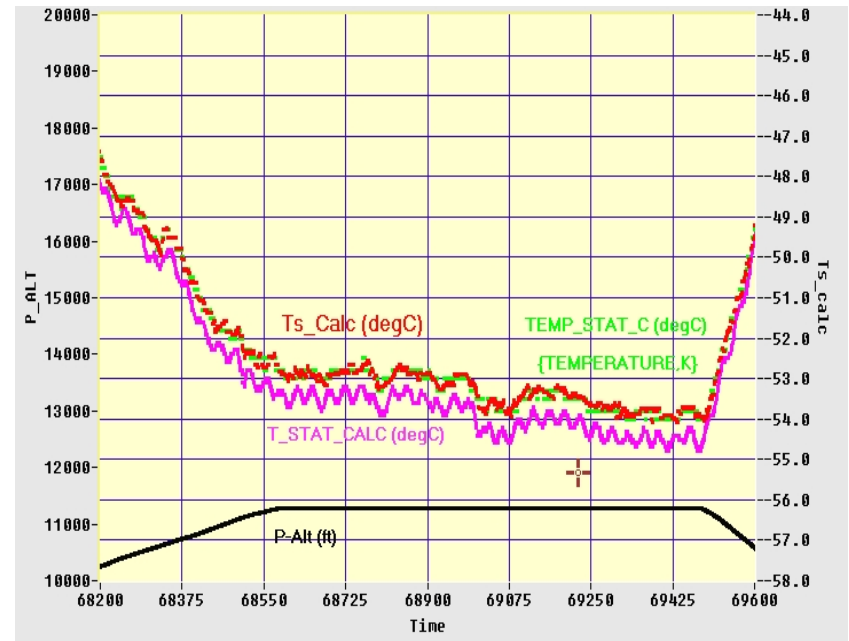
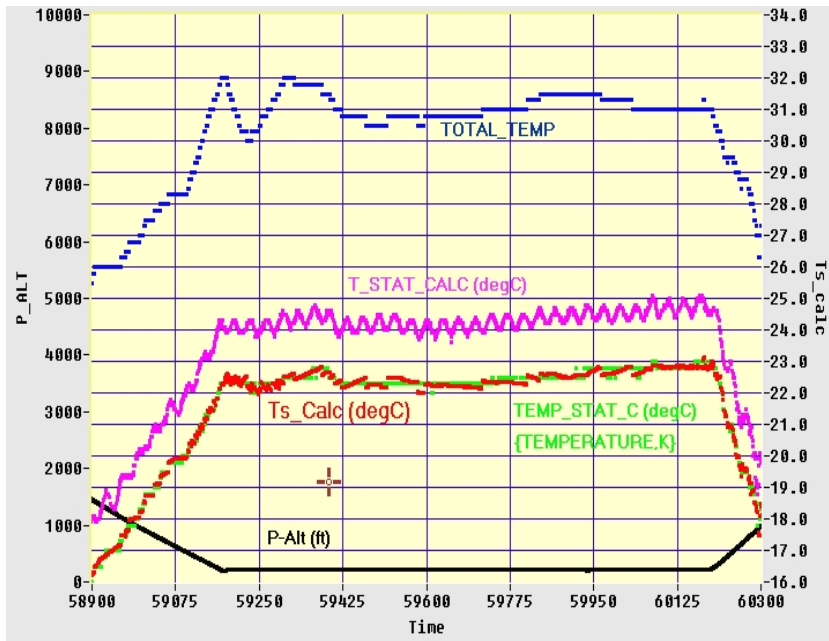
Static Air Temperature

File Name:

nav_dc8_2004mmdd_ra.ict → nav_dc8_2004mmdd_r0.ict → mrgxx_dc8_2004mmdd_r0.ict

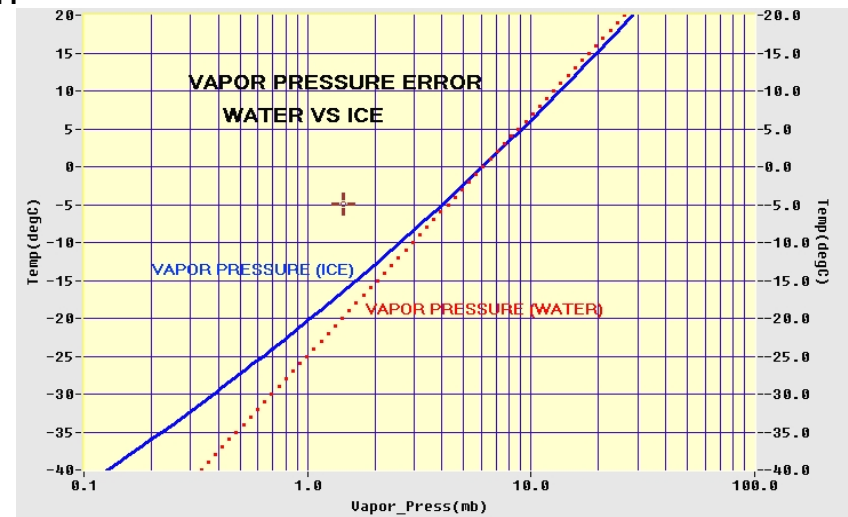
Temperature Parameters:

TEMP_TOTAL (degC) → TEMP_TOTAL (degC) → TOTAL_TEMP, K
TEMP_STAT_C (degC) → TEMP_STAT_C (degC) → TEMPERATURE, K
TEMP_STAT_CALC (degC) →



Comments

- Filter Radiometer and Cryogenic Hygrometer exhibited good correlation with other DC-8 instrument techniques - take a another look at differences.
- Good intercomparison with NOAA WP-3D measurements.
- Consider dynamic response of instrumentation and spatial separation for intercomparison purposes.
- Dew/Frost Ambiguity → →
 - Super-cooled water
 - Utilize descent soundings
- Static Air Temperature
 - Resolution (0.25 deg)
 - Marginal performance



Frost Pt.	Equiv. Dew Pt.	% Vapor Press Err.
-2	-2.3	2
-5	-5.6	5
-10	-11.2	10
-20	-22.2	22